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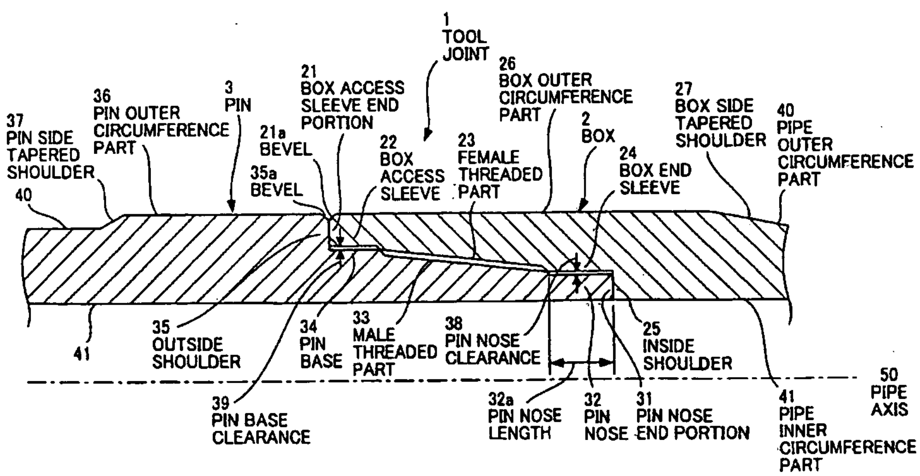

(57) Abstract: The tool joint 1 for drill pipe used for boring oil or gas well. The pin 3 is provided with an outside shoulder 35, a pin base 34 having an outer periphery surface parallel with the pipe axis 50, a male threaded part 33 having a predetermined taper to the pipe axis 50, and a pin nose 32 having an outer periphery surface parallel with the pipe axis 50. The box 2 is provided with a box access sleeve 22 having an inner periphery surface parallel with the pipe axis 50, a female threaded part 23 engaging by thread with the male threaded part 33, a box end sleeve 24 having an inner periphery surface corresponding to the outer periphery surface of the pin nose 32, and an inside shoulder 25. By increasing a total of a mating surface between the outside shoulder 35 and a box access sleeve end portion 21 and a mating surface between the inside shoulder 25 and a pin nose end portion 31, higher torque characteristics is realized without reducing the operativity.

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DESCRIPTION

DOUBLE SHOULDER TOOL JOINT

The present application is based on Japanese patent application No.2004-106970 filed on March 31, 2004, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to a double shoulder tool joint for drill pipe used for boring the oil or gas well, and more particularly to a double shoulder tool joint for drill pipe, which can achieve the higher torque characteristics without decreasing the operating efficiency.

BACKGROUND ART

In the convention art, drill pipes used for boring the extended reach well and horizontal well are connected by means of tool joint. The details of the tool joint are provided in the standards of API (American Petroleum Institute), Spec. 7. In this standard, an outside diameter of the tool joint is formed to be greater than an outside diameter of a pipe body, and an inside diameter of the tool joint is formed to be smaller than an inside diameter of the pipe body, so as to transmit the high torque required for boring the wells. Further, it is recommended that the torque characteristics of the tool joint will be more than 80% of the torque characteristics of the pipe body.

However, when the pipe body is of high strength grade, it

is often that the conditions provided in this standard cannot be satisfied. Accordingly, in the conventional tool joint for drill pipe, there are disadvantages in that the boring efficiency is reduced due to the limitations in the boring conditions and in that the threads are damaged.

For solving the above problems, a double shoulder tool joint for drill pipe with the high torque characteristics is proposed in Japanese Patent No. 3057857 (FIG. 1).

FIG. 1 shows a cross section of the double shoulder tool joint for drill pipe in Japanese Patent No. 3057857. FIG. 2 shows an enlarged cross section of the conventional double shoulder tool joint for drill pipe.

A tool joint 101 comprises a box 102 having a female threaded part 123, and a pin 103 having a male threaded part 133.

The box 102 comprises a box access sleeve 122 with a predetermined taper at an end thereof, a female threaded part 123 with the same predetermined taper as the box access sleeve 122, a box end sleeve 124 with the same predetermined taper as the female threaded part 123, an inside shoulder 125 extended from an end of the box end sleeve 124 to be perpendicular to a pipe axis 150, a pipe inner circumference part 141 to provide a hollow along the pipe axis 150, and a box outer circumference part 126 forming an outer periphery surface of the box 102. The box outer circumference part 126 is construed such that the diameter thereof is gradually increased along the pipe axis 150 from a pipe outer circumference part 140 via a box side tapered shoulder 127.

The pin 103 comprises a pin nose 132 with a predetermined taper at an end thereof, a male threaded part 133 with the same

predetermined taper as the pin nose 132, a pin base 134 with the same predetermined taper as the male threaded part 133, an outside shoulder 135 extended from a base end portion of the pin base 134 to be perpendicular to the pipe axis 150, and a pin outer circumference part 136 constituting an outer periphery surface of the pin 103. The pin outer circumference part 136 is construed such that the diameter thereof is gradually increased along the pipe axis 150 from the pipe outer circumference part 140 via a pin side tapered shoulder 137. In FIGS. 1 and 2, threads of the male and female threaded part 133, 123 are simplified so as to clearly show the taper thereof.

A pin nose length 132a is formed to be short, i.e. about 10mm, to be interchangeable with the threads according to the API standard. In addition, a pin base clearance 139 defined by an outer periphery surface of the pin base 134 and an inner periphery surface of the box access sleeve 122 is formed to have a width of 2.1mm to 2.5mm, to be interchangeable with the threads according to the API standard. A pin nose clearance 138 defined by an outer periphery surface of the pin nose 132 and an inner periphery surface of the box end sleeve 124 is formed to have a width of 2.1mm to 2.5mm.

The box 102 and pin 103 are provided with bevels 121a and 135a formed at a box access sleeve end portion 121 and at an outer periphery surface of an outside shoulder 135, respectively. Herein, the taper of the male threaded part 133 and female threaded part 123 is 2/12.

The box 102 and pin 103 of the conventional tool joint 101 according to the above structure are connected to each other, as

explained below. At first, the box 102 and pin 103 are faced to each other, and the end portion of the pin 103 is inserted into a bore of the box 102. Both or either of the box 102 and pin 103 is rotated and manually clamped till the outside shoulder 135 mates the box access sleeve end portion 121. At the manual clamping, a clearance between the inside shoulder 125 and pin nose end portion 131 is formed to have a width of 0mm to 0.5mm. Next, the pin 103 and box 102 are clamped in a predetermined clamping strength by means of a clamping tool.

According to the conventional tool joint 101, since the outside shoulder 135 and inside shoulder 125 are formed, the plane contact of the outside shoulder 135 and inside shoulder 125 with the corresponding mating surfaces of the box access sleeve end portion 121 and pin nose end portion 131 can be realized, respectively. Further, since the clearance between the inside shoulder 125 and pin nose end portion 131 is formed to have a width of 0mm to 0.5mm at the manual clamping, the high torque value can be obtained, and the tensile stress in the male threaded part 133 and female threaded part 123 can be decreased.

DISCLOSURE OF INVENTION

(Problems to be solved by the Invention)

However, the characteristics of the conventional double shoulder tool joint is not always sufficient to meet the requirement of higher torque characteristics in recent years. Namely, since the pin nose length 132a is short, when the pin nose 132 is compressed in accordance with the progress of thread clamping, the compression bias of the pin nose 132 exceeds an

elastic limit thereof even at a low clamping angle, thereby causing a local plastic deformation of the pin nose 132. As a result, a sufficient clamping angle cannot be provided, so that the structure of the conventional double shoulder tool joint is not always sufficient to satisfy a requirement of higher torque characteristics.

In recent years, the boring of the extended reach well or horizontal well having the length up to 10km is often conducted. In the conventional double shoulder tool joint, following features are required: 1) higher torque characteristics against the significantly increased friction with the bore wall of the well, 2) a larger inside diameter to prevent the decrease in pressure of drilling fluid during the boring, and 3) an outside diameter possibly same as the outside diameter of the outer circumference part of the pipe body to improve the recovery efficiency of boring chip. Herein, so as to realize the high torque characteristics, the mating surface between the pin 103 and box 102 may be increased by increasing the outside diameter and decreasing the inside diameter.

However, as described above, if the inside diameter is decreased, the decrease in pressure of drilling fluid in boring will be aggravated. Further, if the outside diameter is increased, the recovery efficiency of boring chip will be decreased. Still further, if the taper of the male threaded part 133 and female threaded part 123 is decreased to increase the mating area between the pin 103 and box 102, the operative efficiency will be decreased since the screwing operation of the tool joint of this type needs the longer time period.

Accordingly, an object of the invention is to provide the double shoulder tool joint, in which the higher torque characteristics comparing to the conventional device can be provided without decreasing the operative efficiency.

(Means for solving the problems)

For achieving the above object, according to a feature of the present invention, a double shoulder tool joint, comprises a pin including a pin outer circumference part having a predetermined outside diameter, a pipe inner circumference part having a predetermined inside diameter, an outside shoulder having a mating surface perpendicular to a pipe axis, a pin base having an outer periphery surface parallel with the pipe axis, a male threaded part having a predetermined taper to the pipe axis, and a pin nose having an outer periphery surface parallel with the pipe axis and a mating surface perpendicular to the pipe axis, and a box including a box outer circumference part having a predetermined outside diameter, a pipe inner circumference part having a predetermined inside diameter, a box access sleeve having a mating surface mating the mating surface of the outside shoulder and an inner periphery surface corresponding to the outer periphery surface of the pin base and formed in parallel with the pipe axis, a female threaded part engaging by thread with the male threaded part, a box end sleeve having an inner periphery surface corresponding to the outer periphery surface of the pin nose and formed in parallel with the pipe axis, and an inside shoulder having a mating surface mating the mating surface of the pin nose and formed perpendicular to the pipe axis.

In the present invention, preferably, a clearance between

the outer periphery surface of the pin nose and the inner periphery surface of the box end sleeve has a width of 0.5mm to 1.6mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

In the present invention, preferably, a clearance between the outer periphery surface of the pin base and the inner periphery surface of the box access sleeve has a width of 0.5mm to 1.6mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

In the present invention, preferably, a length of the pin nose is 12.7mm to 38.1mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

According to another feature of the present invention, a double shoulder tool joint, comprises a pin including a pin outer circumference part having a predetermined outside diameter, a pipe inner circumference part having a predetermined inside diameter, an outside shoulder having a mating surface perpendicular to a pipe axis, a pin base having an outer periphery surface, a male threaded part having a predetermined taper to the pipe axis, and a pin nose having an outer periphery surface with a taper smaller than the taper of the male threaded part and a mating surface perpendicular to the pipe axis, and a box including a box outer

circumference part having a predetermined outside diameter, a pipe inner circumference part having a predetermined inside diameter, a box access sleeve having a mating surface mating the mating surface of the outside shoulder and an inner periphery surface corresponding to the outer periphery surface of the pin base, a female threaded part engaging by thread with the male threaded part, a box end sleeve having an inner periphery surface corresponding to the outer periphery surface of the pin nose and formed in parallel with the pipe axis, and an inside shoulder having a mating surface mating the mating surface of the pin nose and formed perpendicular to the pipe axis.

(Effect of the Invention)

According to the double shoulder tool joint of the present invention, the outer periphery surface of the pin base and the inner periphery surface of the box access sleeve are formed in parallel with the pipe axis, and the inner periphery surface of the pin nose and the outer periphery surface of the box end sleeve are formed in parallel with the pipe axis, so that the mating surface between the box access sleeve end portion and the outside shoulder of the pin as well as the mating surface between the pin nose end portion and the inside shoulder of the box are increased compared with those in the conventional double shoulder tool joint, thereby dispersing the stress concentrated on the outside shoulder and inside shoulder. Therefore, the torque resistance performance of the tool joint can be improved and the drilling efficiency can be improved. Herein, the meaning of limitation "parallel" includes the state substantially parallel, i.e. the taper is small.

According to the double shoulder tool joint of the present invention, the clearance between the outer periphery surface of the pin nose and the inner periphery surface of the box end sleeve is formed to have a width of 0.5mm to 1.6mm, so that the operativity can be improved and the mating surface between the pin nose end portion and the inside shoulder can be increased.

According to the double shoulder tool joint of the present invention, the clearance between the outer periphery surface of the pin base and the inner periphery surface of the box access sleeve is formed to have a width of 0.5mm to 1.6mm, so that the operativity can be improved and the mating surface between the box access sleeve end portion and the outside shoulder can be increased.

According to the double shoulder tool joint of the present invention, when the outer circumference part of the box or pin has an outside diameter of 114.3mm to 190.5mm and the inner circumference part of the box or pin has an inside diameter of 50mm to 114.3mm, the pin nose is formed to have a length of 12.7mm to 38.1mm, so that the increase of the elastic limit of the torsion given to the pin nose in accordance with the progress of screwing can be expected, the torque resistance can be improved, and the lifetime of the device can be prolonged.

BRIEF DESCRIPTION OF DRAWINGS

Preferred embodiment according to the present invention will be explained below in conjunction with the appended drawings, wherein:

FIG. 1 is a cross sectional view along a pipe axis of the

conventional double shoulder tool joint;

FIG. 2 is an enlarged cross sectional view of the conventional double shoulder tool joint;

FIG. 3 is a diagram showing the whole structure of the double shoulder tool joint in a preferred embodiment of the present invention;

FIG. 4 is a cross sectional view of the double shoulder tool joint in a preferred embodiment of the present invention along the pipe axis in Fig. 3;

FIG. 5 is an enlarged cross sectional view of the double shoulder tool joint in the preferred embodiment of the present invention;

FIG. 6A is a cross section along line A-A in Fig. 4 showing the mating surface between the outside shoulder and the box access sleeve end portion of the double shoulder tool joint in the preferred embodiment;

FIG. 6B is a cross section along line A'-A' in Fig. 1 showing the mating surface between the outside shoulder and the box access sleeve end portion of the conventional double shoulder tool joint;

FIG. 7A is a cross section along line B-B in Fig. 4 showing the mating surface between the inside shoulder and the pin nose end portion of the double shoulder tool joint in the preferred embodiment;

FIG. 7B is a cross section along line B'-B' in Fig. 1 showing the mating surface between the inside shoulder and the pin nose end portion of the conventional double shoulder tool joint;

FIG. 8 is a graph showing the yield strength of the examples 1, 2 and a comparative example in a clamping test;

FIG. 9A is a diagram showing a stress distribution provided by Finite Element Method (FEM) analysis in a main part of the double shoulder tool joint in the preferred embodiment of the present invention; and

FIG. 9B is a diagram showing a stress distribution provided by FEM analysis in a main part of the double shoulder tool joint in the comparative example.

BEST MODE FOR CARRYING OUT THE INVENTION

(Whole structure of tool joint)

FIG. 3 shows a whole structure of a double shoulder tool joint in a preferred embodiment according to the present invention. The double shoulder tool joint 1 is a pipe joint tool for engaging a pin 3 with a box 2 by threaded parts, in which the box 2 is formed at one end of a drill pipe 4 and provided with a female threaded part 23, and the pin 3 is formed at one end of another drill pipe 4 and provided with a male threaded part 33. The drill pipe 4 is configured to sequentially connect to the other drill pipes 4 by means of the tool joint 1 comprising the box 2 and pin 3.

(Structure of tool joint)

FIG. 4 is a cross section along a pipe axis in Fig. 3 showing the double shoulder tool joint in a preferred embodiment according to the invention.

FIG. 5 is an enlarged cross section showing the detailed structure of the double shoulder tool joint in the preferred embodiment according to the invention.

The tool joint 1 is composed of the box 2 having the female threaded part 23 and the pin 3 having the male threaded part 33.

The box 2 comprises a box access sleeve 22 having an inner periphery surface which is in parallel with a pipe axis 50, a female threaded part 23 formed adjacent to the box access sleeve 22 and having a taper of 2/12, a box end sleeve 24 having an inner periphery surface which is in parallel with the pipe axis 50, an inside shoulder 25 formed to be perpendicular to the pipe axis 50, a pipe inner circumference part 41 to provide a hollow along a pipe axis 50, and a box outer circumference part 26 constituting an outer periphery surface of the box 2. The box outer circumference part 26 is formed such that the diameter thereof is gradually increased from a pipe outer circumference part 40 via a box side tapered shoulder 27. In FIGS. 4 and 5, threads of the male and female threaded part 33, 23 are simplified so as to clearly show the taper thereof.

Preferably, the box access sleeve 22 and the box end sleeve 24 may have the inner periphery surface in parallel with the pipe axis 50, respectively, but the invention is not limited thereto. The box access sleeve 22 and the box end sleeve 24 may have the inner periphery surface having a taper smaller than a taper of the female threaded part 23 or the male threaded part 33. In particular, the taper of the inner periphery surface of the box access sleeve 22 and the box end sleeve 24 to the pipe axis 50 is preferably not greater than 1/12.

In the invention, the meaning of limitation "parallel" includes the state substantially parallel, i.e. the taper is small. Similarly, the meaning of limitation "perpendicular to pipe axis" includes the state substantially perpendicular to pipe axis.

The pin 3 comprises a pin nose 32 having an outer periphery

surface formed in parallel with the pipe axis 50, a male threaded part 33 formed adjacent to the pin nose 32 and having a taper of 2/12, a pin base 34 having an outer periphery surface extending from an pin outer circumference part 36 and formed in parallel with the pipe axis 50, an outside shoulder 35 formed to be perpendicular to the pipe axis 50, and the pin outer circumference part 36 constituting an outer periphery surface of the pin 3. The pin outer circumference part 36 is formed such that the diameter thereof is gradually increased from a pipe outer circumference part 40 via a pin side tapered shoulder 37.

Preferably, the pin nose 32 and the pin base 34 may have the outer periphery surfaces formed in parallel with the pipe axis 50, respectively, but the invention is not limited thereto. The pin nose 32 and the pin base 34 may have the outer periphery surfaces having a taper smaller than a taper of the female threaded part 23 or the male threaded part 33. In particular, the taper of the outer periphery surfaces of the pin nose 32 and the pin base 34 to the pipe axis 50 is preferably not greater than 1/12.

In the invention, the meaning of limitation "parallel" includes the state substantially parallel, i.e. the taper is small. Similarly, the meaning of limitation "perpendicular to pipe axis" includes the state substantially perpendicular to pipe axis.

In the present invention, it is important to form the outer periphery surface of the pin nose 32 and the inner periphery surface of the box end sleeve 24 in parallel with the pipe axis 50. Considering with the simplicity and easiness in fabrication, the outer periphery surface of the pin base 34 and the inner periphery of the box access sleeve 22 may not be in parallel with the pipe

axis 50, and may be formed with a taper similar to the conventional device.

When the outside diameter of the box or pin is 114.3mm to 190.5mm and the inside diameter of the box or pin is 50mm to 114.3mm, a length 32a of the pin nose 32 is preferably from 11mm to 49mm. More preferably, the pin nose length 32a may be from 12.7mm to 38.1mm, considering with the easiness in handling and difficulty in fabrication.

A clearance 38 between the outer periphery surface of the pin nose 32 and the inner periphery surface of the box end sleeve 24 (a pin nose clearance 38) is construed to have a width of 0.5mm to 1.6mm. It is because that the operativity is deteriorated when the pin nose clearance 38 has a width less than 0.5mm, and that the mating surface between the pin nose end portion 31 and the inside shoulder 25 of the box 2 cannot be increased when the pin nose clearance 38 has a width greater than 1.6mm.

A clearance 39 between the outer periphery surface of the pin base 34 and the inner periphery surface of the box access sleeve 22 (a pin base clearance 39) is construed to have a width of 0.5mm to 1.6mm. It is because that the operativity is deteriorated when the pin base clearance 39 has a width less than 0.5mm, and that the mating surface between the box access sleeve 21 and the outside shoulder 35 of the pin 3 cannot be increased when the pin base clearance 39 has a width greater than 1.6mm.

Materials of the box 2 and pin 3 are not specifically limited, if they have a sufficient strength which meets the standard according to the API Spec.7.

(Connection of tool joint)

The connection of the drill pipes by using the tool joint 1 in the preferred embodiment of the present invention will be conducted as follows. At first, the box 2 and pin 3 are faced to each other, and an end portion of the pin 3 is inserted into a bore of the box 2. Both or either of the box 2 and pin 3 is rotated to be clamped till the outside shoulder 35 and the box access sleeve end portion 21 mate each other, further the inside shoulder 25 and the pin nose end portion 31 mate each other.

(Effect of the preferred embodiment)

According to the preferred embodiment of the present invention, the inner periphery surface of the box access sleeve 22 and the outer periphery surface of the pin base 34 are formed in parallel with the pipe axis 50, and the inner periphery surface of the box end sleeve 24 and the outer periphery surface of the pin nose 32 are formed in parallel with the pipe axis 50, so that it is possible to increase thickness of the pin nose 32 and box access sleeve 22, compared with the conventional tool joint. Accordingly, the mating surface between the box access sleeve end portion 21 and the outside shoulder 35 and the mating surface between the pin nose end portion 31 and inside shoulder 25 can be increased, compared with the conventional tool joint, in which the inner periphery surface of the box access sleeve and the outer periphery surface of the pin base, and the inner periphery surface of the box end sleeve and the outer periphery surface of the pin nose have the same taper as the male or female threaded part. According to this structure, the torque resistance can be improved and a lifetime of the tool joint can be prolonged.

Further, by increasing the pin nose length 32a, it is

possible to reduce a torsion due to displacement of the pin nose in accordance with the progress of screwing, compared with a short pin (10mm length) in the conventional tool joint, thereby realizing a further screwing. According to this structure, the torque resistance can be improved and a lifetime of the tool joint can be prolonged.

However, if the pin nose length 32a is greater than or equal to 50mm, the rigidity of the pin nose 32 will be deteriorated, a greater clamping angle will be required, and the abrasion of the female and male threaded parts 23, 33 and inside shoulder 25 will be increased. As a result, the lifetime of the device will be shortened.

FIG. 6A is a cross section along line A-A in Fig. 4 showing the mating surface between the outside shoulder and the box access sleeve end portion of the double shoulder tool joint in the preferred embodiment of the invention, and FIG. 6B is a cross section along line A'-A' in Fig. 1 showing the mating surface between the outside shoulder and the box access sleeve end portion of the conventional double shoulder tool joint.

In FIG. 6A, "a" indicates a width of the mating surface where the outside shoulder 35 mates the box access sleeve end portion 21.

On the other hand, in FIG. 6B, "b" indicates a width of the mating surface where the outside shoulder 135 mates the box access sleeve end portion 121.

As clearly shown in FIGS. 6A and 6B, a relationship a>b is established, i.e. the width a in the present invention is greater than width b in the conventional tool joint. In other words, since

the box access sleeve 22 is formed to extend from a box access sleeve-side end of the female threaded part 23 and in parallel with the pipe axis 50, the width of the mating surface of the present invention is different from that in the conventional tool joint, in which the box access sleeve end portion 121 having a same taper as the female threaded part 123 mates the outside shoulder 135.

As a result, the mating surface between the outside shoulder and the box access sleeve end portion of the present invention becomes greater than that of the conventional tool joint.

FIG. 7A is a cross section along line B-B in Fig. 4 showing the mating surface between the inside shoulder and the pin nose end portion of the double shoulder tool joint in the preferred embodiment of the invention, and FIG. 7B is a cross section along line B'-B' in Fig. 1 showing the mating surface between the inside shoulder and the pin nose end portion of the conventional double shoulder tool joint.

In FIG. 7A, "a'" indicates a width of the mating surface where the inside shoulder 25 mates the pin nose end portion 31.

On the other hand, in FIG. 7B, "b'" indicates a width of the mating surface where the inside shoulder 125 mates the pin nose end portion 131.

As clearly shown in FIGS. 7A and 7B, a relationship a'>b' is established, i.e. the width a' in the present invention is greater than width b' in the conventional tool joint. In other words, since the pin nose 32 is formed to extend from a pin nose-side end of the male threaded part 33 and in parallel with the pipe axis 50, the width of the mating surface of the present invention is different from that in the conventional tool joint, in which

the pin nose end portion 131 having a same taper as the male threaded part 133 mates the inside shoulder 125.

As a result, the mating surface between the inside shoulder and the pin nose end portion of the present invention becomes greater than that of the conventional tool joint.

[Example 1]

Example 1 of the present invention will be explained below.

In the Example 1, the pin and box are made from SAE 4137H based material (steel material for structure with assured hardenability) according to the AISI (American Iron and Steel Institute) Standard. Representative components of SAE 4137H based material are C:0.37% by weight, Si:0.2% by weight, Mn:1.0% by weight, Cr:1.0% by weight and Mo:0.2% by weight. The strength of the material is determined in accordance with the API Spec. 7. The pin and box having an outside diameter of 177.8mm and an inside diameter of 108.0mm are employed. The pin and box are mutually screwed and manually clamped. This manual clamping angle is determined as a manual clamping position for a reference. Next, a clamping angle and a torque when the pin and box are clamped by means of a clamping tool with a predetermined torque are plotted to obtain a torsional yield strength. At this time, the pin nose is protruded from an end of the male threaded part in parallel with the pipe axis and the pin nose is not tapered. The pin nose length is 21mm.

The result of the test is shown in FIG. 8 and Table 1. From this result, it is understood that the torsional yield of the tool joint in the Example 1 begins at 108,480N·m (at a clamping angle

of 43°).

[Table 1]

	Example 1	Example 2	Comparative Example
Taper of pin nose	0	0	2/12
Pin nose length (mm)	21	11	11
Pin nose clearance (mm)	1.1	1.0	1.7
Pin base clearance (mm)	1.1	1.0	1.7
Total mating surface of shoulders (mm^2)	9,935	9,935	9,084
Torsional yield strength (N·m)	108,480	101,700	82,716
Clamping angle at the beginning of torsional yield (°)	43	29	24

[Example 2]

Example 2 of the present invention will be explained below.

The Example 2 is construed same as the Example 1, except the pin nose length is 11mm, to obtain a torsional yield strength.

The result of the test is shown in FIG. 8 and Table 1. From this result, it is understood that the torsional yield of the tool joint in the Example 2 begins at 101,700N·m (at a clamping angle of 29°).

[Comparative Example]

A Comparative Example to be compared with the Examples 1 and 2 of the present invention is construed same as the Example 1, except the taper of the pin nose is 2/12 and the pin nose length is 11mm, to obtain a torsional yield strength.

The result of the test is shown in FIG. 8 and Table 1. From this result, it is understood that the torsional yield of the tool joint in the Comparative Example begins at 82,716N·m (at a clamping

angle of 24°).

In the Examples 1 and 2, it is confirmed that the total of the mating surface between the outside shoulder and the box access sleeve end portion and the mating surface between the inside shoulder and the pin nose end portion is increased by about 10% than that in the comparative example, as shown in Table 1.

The torsional yield strength of the tool joint in the Example 1 is increased by about 31% than the torsional yield strength of the comparative example, as clearly shown in FIG. 8 and Table 1, so that it is confirmed that the torque resistance is improved. From this result, it is understood that the tool joint of Example 1 has higher torque characteristics by increasing the total of the mating surface between the outside shoulder and the box access sleeve end portion and the mating surface between the inside shoulder and the pin nose end portion, and by increasing the pin nose length.

In addition, the torsional yield strength of the tool joint by the Example 1 is 87.6% of the torsional yield strength of a pipe body (123,800 N·m). This value is higher than 80% of the torsional yield strength of a pipe body, which is a recommended value in the API standard.

Herein, the tapers of the male threaded part and female threaded part in the Example 1 are 2/12, same as those in the comparative example. Therefore, the operativity in screwing of Example 1 is similar to that of the Comparative example.

Further, the torsional yield strength of the tool joint in the Example 2 is increased by about 23% than the torsional yield strength of the comparative example, as clearly shown in FIG. 8

and Table 1, so that it is confirmed that the torque resistance is improved. From this result, it is understood that the tool joint of Example 2 has higher torque characteristics by increasing the total of the mating surface between the outside shoulder and the box access sleeve end portion and the mating surface between the inside shoulder and the pin nose end portion.

In addition, the torsional yield strength of the tool joint by Example 2 is 82.1% of the torsional yield strength of the pipe body (123,800 N·m). This value is higher than 80% of the torsional yield strength of the pipe body, which is a recommended value in the API standard.

Herein, the tapers of the male threaded part and female threaded part in the Example 2 are 2/12, same as those in the Comparative example. Therefore, the operativity in screwing of Example 2 is similar to that of the Comparative example.

(Confirmation of torque characteristics by FEM analysis)

FIG. 9A is a diagram showing a stress distribution provided by Finite Element Method (FEM) analysis in a main part of the double shoulder tool joint in the preferred embodiment of the present invention, and FIG. 9B is a diagram showing a stress distribution provided by FEM analysis in a main part of the double shoulder tool joint in the comparative example. The difference in stress distributions in the Example 1 of the present invention and the comparative example will be explained below by comparing the largest stress areas (meshed area) thereof, in which a stress of 91.8kgf/mm^2 to 133kgf/mm^2 is generated. Herein, the yield stress of pin 3, 103 and yield stress of box 2, 102 are 91.4kgf/mm^2.

In FIG. 9B, the stress distribution of the pin 103 in the

comparative example is illustrated. A compressive stress generated at the inside shoulder 125 is mutually combined with a diameter reduction stress generated at an inside shoulder-side end of engaging surfaces of the male threaded part 133 of the pin 103 and the female threaded part 123. A cross section of the pin nose 132 shows that the stress greater than the yield stress is generated over all area of the pin nose 132. Further, the stress greater than the yield stress is generated in an area extending from the box access sleeve 122 to an outside shoulder-side end of engaging surfaces of the male threaded part 133 and the female threaded part 123.

On the other hand, in FIG. 9A, the stress distribution of the pin 3 having the pin nose length 32a of 21mm in the Example 1 is illustrated. Even if the same torque as the comparative example is applied, a compressive stress generated at the inside shoulder 25 mating the pin nose end portion 31 does not interfere with a diameter reduction stress generated at an inside shoulder-side end of engaging surfaces of the male threaded part 33 of the pin 3 and the female threaded part 23. A cross section of the pin nose 32 shows that the stress causing the yield is not generated over all area of the pin nose 32, namely, the stress causing the yield is partially suppressed. Further, the stress causing the yield is not generated over all area extending from the box access sleeve 22 to an outside shoulder-side end of engaging surfaces of the male threaded part 33 and the female threaded part 23, namely, the stress causing the yield is partially suppressed.

For reference, an area in which stress of 82.6kgf/mm^2 to 91.8kg f/mm^2 is generated and an area in which stress of 73.4 kgf/mm^2

to 82.6kg f/mm^2 is generated are shown in FIG. 9A and 9B. On the other hand, the distribution of stress generated in other areas such as the female threaded part 23, 123 or male threaded part 33, 133 is omitted from illustration.

As described above, the tool joint of the Example 1 can be provided with a larger rotation angle and higher torque can be applied thereto, compared with a comparative example.

INDUSTRIAL APPLICABILITY

The double shoulder tool joint according to the present invention is useful as a tool joint for drill pipe used for boring of oil and gas well, and more particularly, is suitable for boring the extended reach well or the horizontal well, which extends to 10km.

CLAIMS

1. A double shoulder tool joint, comprising:

a pin including:

a pin outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

an outside shoulder having a mating surface perpendicular to a pipe axis;

a pin base having an outer periphery surface parallel with the pipe axis;

a male threaded part having a predetermined taper to the pipe axis; and

a pin nose having an outer periphery surface parallel with the pipe axis and a mating surface perpendicular to the pipe axis; and

a box including:

a box outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

a box access sleeve having a mating surface mating the mating surface of the outside shoulder and an inner periphery surface corresponding to the outer periphery surface of the pin base and formed in parallel with the pipe axis;

a female threaded part engaging by thread with the male threaded part;

a box end sleeve having an inner periphery surface

corresponding to the outer periphery surface of the pin nose and formed in parallel with the pipe axis; and

an inside shoulder having a mating surface mating the mating surface of the pin nose and formed perpendicular to the pipe axis.

2. The double shoulder tool joint, according to claim 1, wherein:

a clearance between the outer periphery surface of the pin nose and the inner periphery surface of the box end sleeve has a width of 0.5mm to 1.6mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

3. The double shoulder tool joint, according to claim 1, wherein:

a clearance between the outer periphery surface of the pin base and the inner periphery surface of the box access sleeve has a width of 0.5mm to 1.6mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

4. The double shoulder tool joint, according to claim 1, wherein:

a length of the pin nose is 12.7mm to 38.1mm, when the box outer circumference part or the pin outer circumference part has

an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

5. A double shoulder tool joint, comprising:

a pin including:

a pin outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

an outside shoulder having a mating surface perpendicular to a pipe axis;

a pin base having an outer periphery surface;

a male threaded part having a predetermined taper to the pipe axis; and

a pin nose having an outer periphery surface with a taper smaller than the taper of the male threaded part and a mating surface perpendicular to the pipe axis; and

a box including:

a box outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

a box access sleeve having a mating surface mating the mating surface of the outside shoulder and an inner periphery surface corresponding to the outer periphery surface of the pin base;

a female threaded part engaging by thread with the male

threaded part;

a box end sleeve having an inner periphery surface corresponding to the outer periphery surface of the pin nose and formed in parallel with the pipe axis; and

an inside shoulder having a mating surface mating the mating surface of the pin nose and formed perpendicular to the pipe axis.

AMENDED CLAIMS
[received by the International Bureau on 09 September 2005 (09.09.2005);
original claims 1 and 5 amended; new claims 6 and 7 added;
remaining claims unchanged (4 pages)]

1. A double shoulder tool joint, comprising:

a pin including:

a pin outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

an outside shoulder having a mating surface perpendicular to a pipe axis;

a pin base having an outer periphery surface parallel with the pipe axis;

a male threaded part having a predetermined taper to the pipe axis; and

a pin nose having an outer periphery surface parallel with the pipe axis along an entire length of the pin nose including a tip portion and a mating surface perpendicular to the pipe axis; and

a box including:

a box outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

a box access sleeve having a mating surface mating the mating surface of the outside shoulder and an inner periphery surface corresponding to the outer periphery surface of the pin base and formed in parallel with the pipe axis;

a female threaded part engaging by thread with the male threaded part;

a box end sleeve having an inner periphery surface corresponding to the outer periphery surface of the pin nose and formed in parallel with the pipe axis; and

an inside shoulder having a mating surface mating the mating surface of the pin nose and formed perpendicular to the pipe axis.

2. The double shoulder tool joint, according to claim 1, wherein:

a clearance between the outer periphery surface of the pin nose and the inner periphery surface of the box end sleeve has a width of 0.5mm to 1.6mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

3. The double shoulder tool joint, according to claim 1, wherein:

a clearance between the outer periphery surface of the pin base and the inner periphery surface of the box access sleeve has a width of 0.5mm to 1.6mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

4. The double shoulder tool joint, according to claim 1, wherein:

a length of the pin nose is 12.7mm to 38.1mm, when the box

outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

5. The double shoulder tool joint, according to claim 1, wherein:

a clearance between the outer periphery surface of the pin nose and the inner periphery surface of the box end sleeve has a width of 0.5mm to 1.6mm and a length of the pin nose is 12.7mm to 38.1mm, when the box outer circumference part or the pin outer circumference part has an outside diameter of 114.3mm to 190.5mm and the pipe inner circumference part of the box or pin has an inside diameter of 50.0mm to 114.3mm.

6. The double shoulder tool joint, according to claim 1, wherein:

the width of the clearance between the outer periphery surface of the pin nose and the inner periphery surface of the box end sleeve is substantially same as that of a clearance between the outer periphery surface of the pin base and the inner periphery surface of the box access sleeve.

7. A double shoulder tool joint, comprising:

a pin including:

a pin outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined

inside diameter;

an outside shoulder having a mating surface perpendicular to a pipe axis;

a pin base having an outer periphery surface;

a male threaded part having a predetermined taper to the pipe axis; and

a pin nose having an outer periphery surface parallel with the pipe axis along an entire length of the pin nose including a tip portion and a mating surface perpendicular to the pipe axis; and

a box including:

a box outer circumference part having a predetermined outside diameter;

a pipe inner circumference part having a predetermined inside diameter;

a box access sleeve having a mating surface mating the mating surface of the outside shoulder and an inner periphery surface with a taper smaller than the taper of the female threaded part corresponding to the outer periphery surface of the pin base;

a female threaded part engaging by thread with the male threaded part;

a box end sleeve having an inner periphery surface corresponding to the outer periphery surface of the pin nose and formed in parallel with the pipe axis; and

an inside shoulder having a mating surface mating the mating surface of the pin nose and formed perpendicular to the pipe axis.

STATEMENT

Concerning the above identified International Application, claims 1 and 5 have been amended, claims 2, 3, and 4 are retain unchanged, and Claims 6 and 7 are new so as to clarify the features of the present invention. Support for the amended claims is found throughout the description and drawings. The above amendments to the claims do not go beyond the scope of the disclosure of the application as filed, so that the amendments do not add any New Matter to the application.

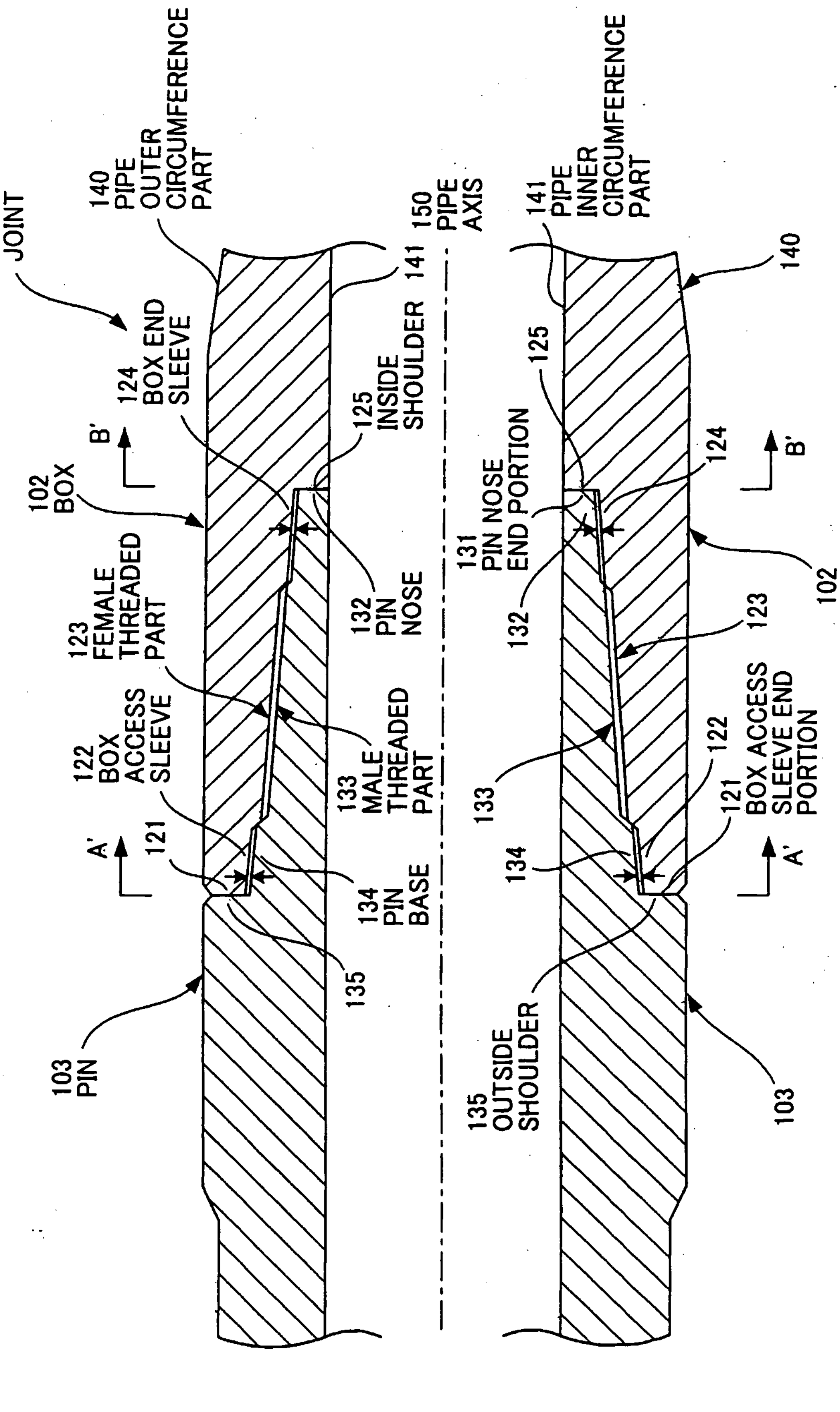


FIG.1 PRIOR ART

FIG.2 PRIOR ART

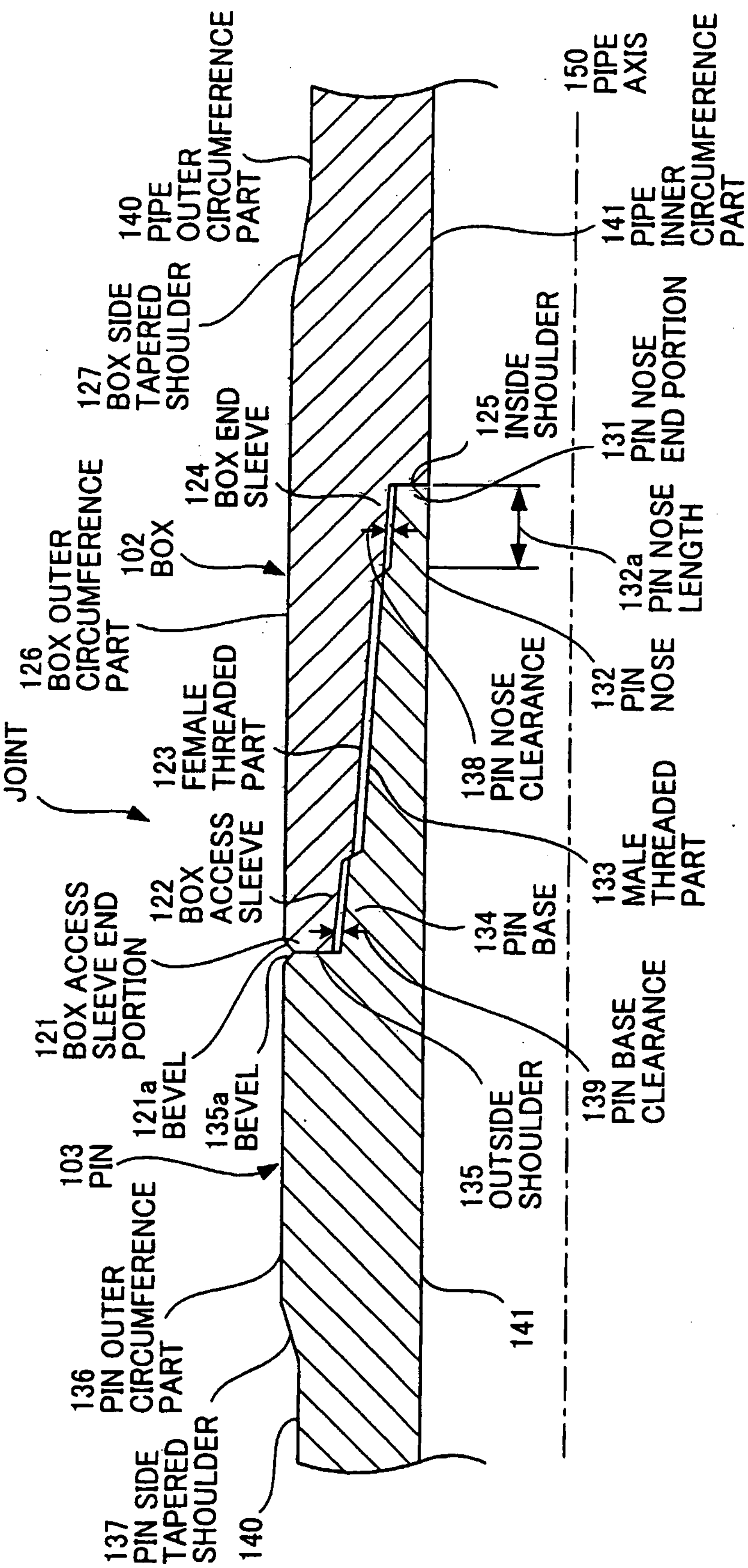


FIG. 3

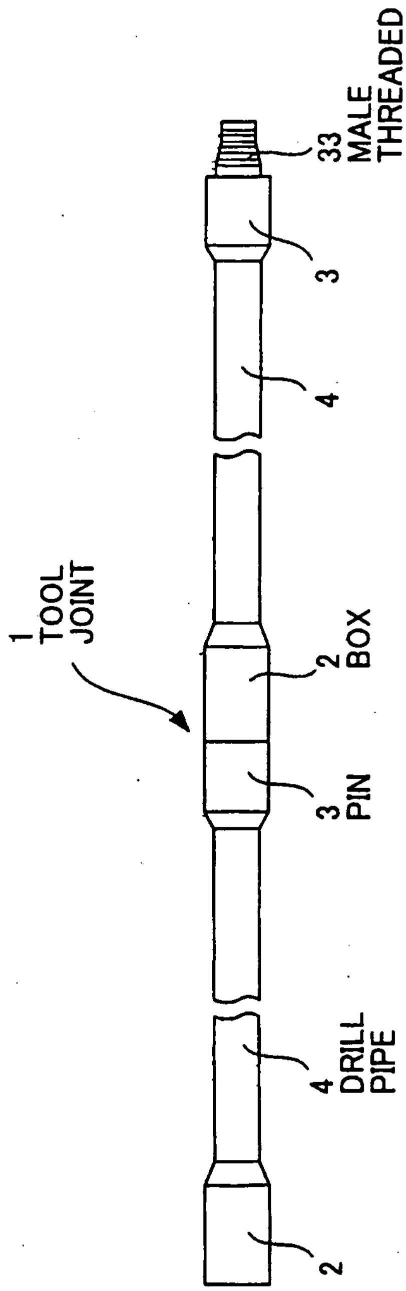


FIG. 4

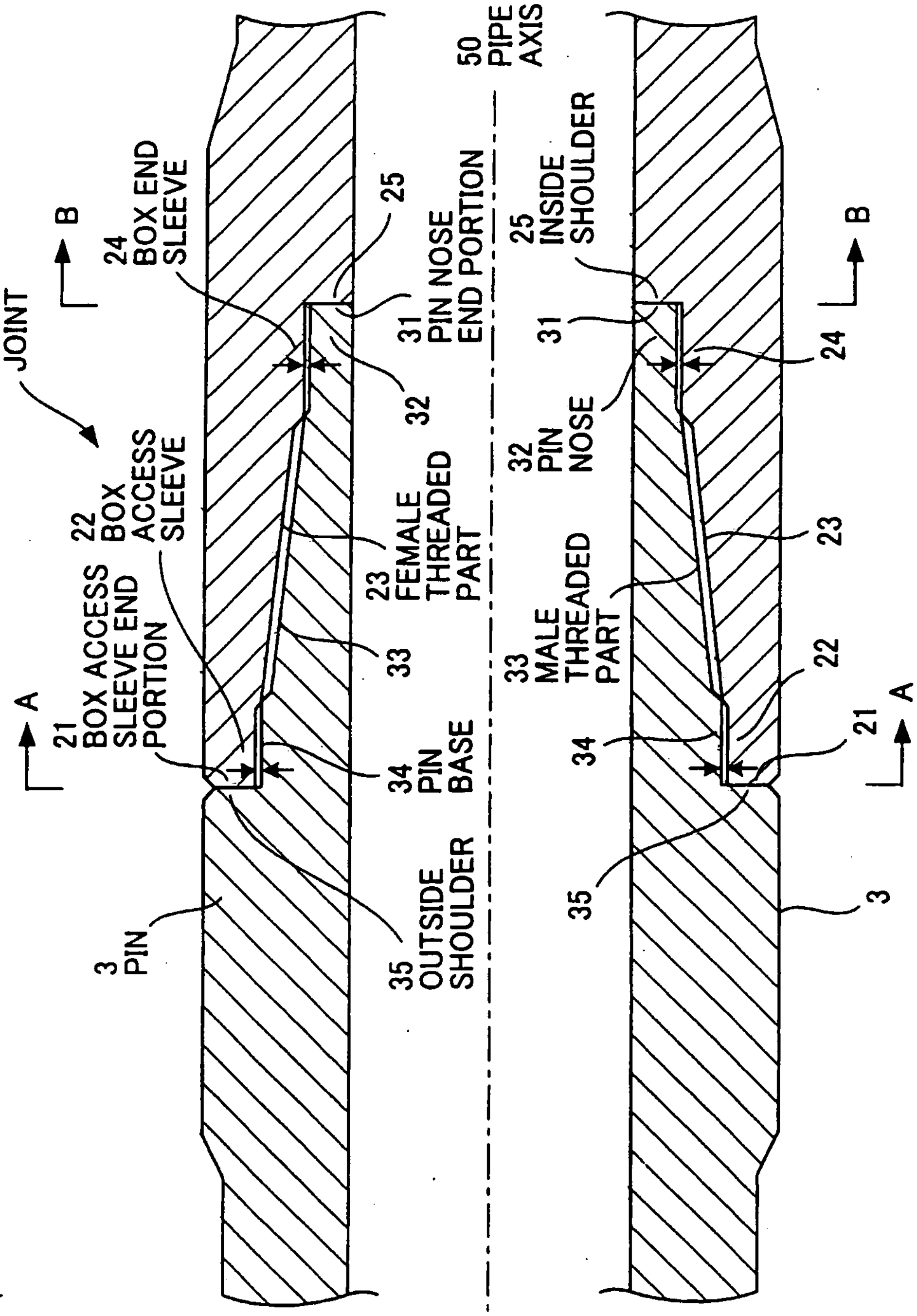

1 TOOL JOINT
24 BOX END SLEEVE
22 BOX ACCESS SLEEVE
21 BOX ACCESS SLEEVE END PORTION
3 PIN
25
31 PIN NOSE END PORTION
32
23 FEMALE THREADED PART
33
34 PIN BASE
35 OUTSIDE SHOULDER
50 PIPE AXIS
25 INSIDE SHOULDER
31
32 PIN NOSE
33 MALE THREADED PART
34
35
24
23
22
21
3
A
B

FIG. 5

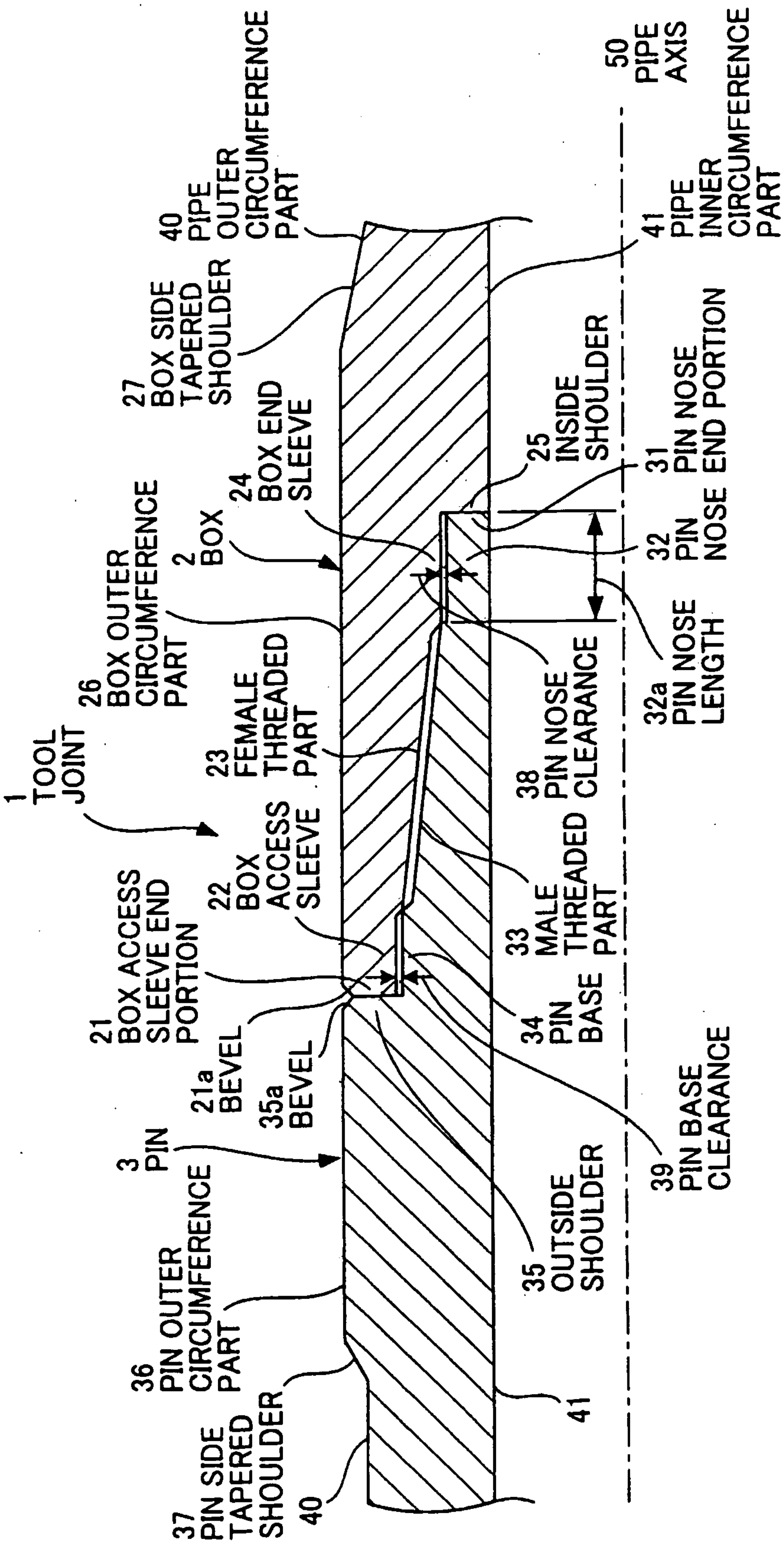

1 TOOL JOINT
2 BOX
3 PIN
21 BOX ACCESS SLEEVE END PORTION
21a BEVEL
22 BOX ACCESS SLEEVE
23 FEMALE THREADED PART
24 BOX END SLEEVE
25 INSIDE SHOULDER
26 BOX OUTER CIRCUMFERENCE PART
27 BOX SIDE TAPERED SHOULDER
31 PIN NOSE END PORTION
32 PIN NOSE
32a PIN NOSE LENGTH
33 MALE THREADED PART
34 PIN BASE
35 OUTSIDE SHOULDER
35a BEVEL
36 PIN OUTER CIRCUMFERENCE PART
37 PIN SIDE TAPERED SHOULDER
38 PIN NOSE CLEARANCE
39 PIN BASE CLEARANCE
40 PIPE OUTER CIRCUMFERENCE PART
40
41 PIPE INNER CIRCUMFERENCE PART
41
50 PIPE AXIS

FIG.6B

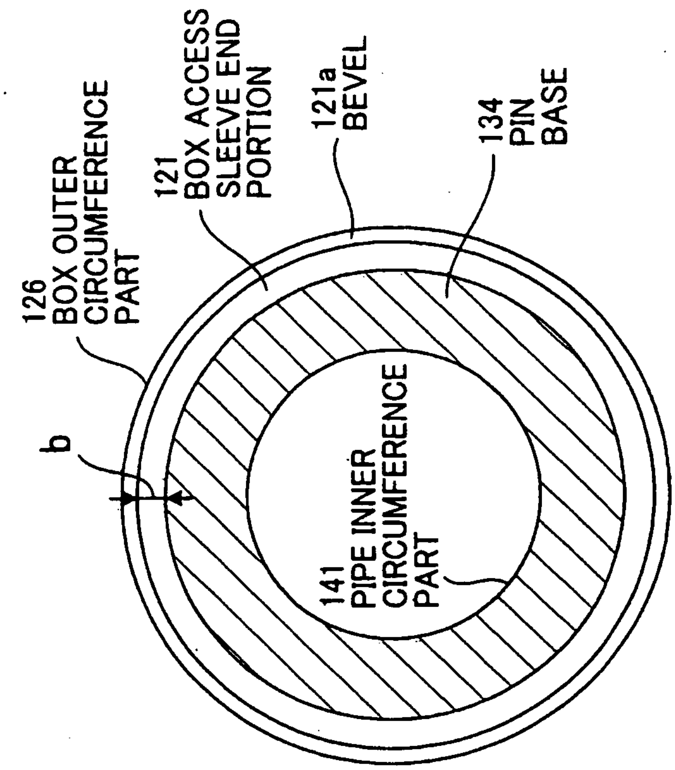

b
126
BOX OUTER
CIRCUMFERENCE
PART
121
BOX ACCESS
SLEEVE END
PORTION
121a
BEVEL
134
PIN
BASE
141
PIPE INNER
CIRCUMFERENCE
PART

FIG.6A

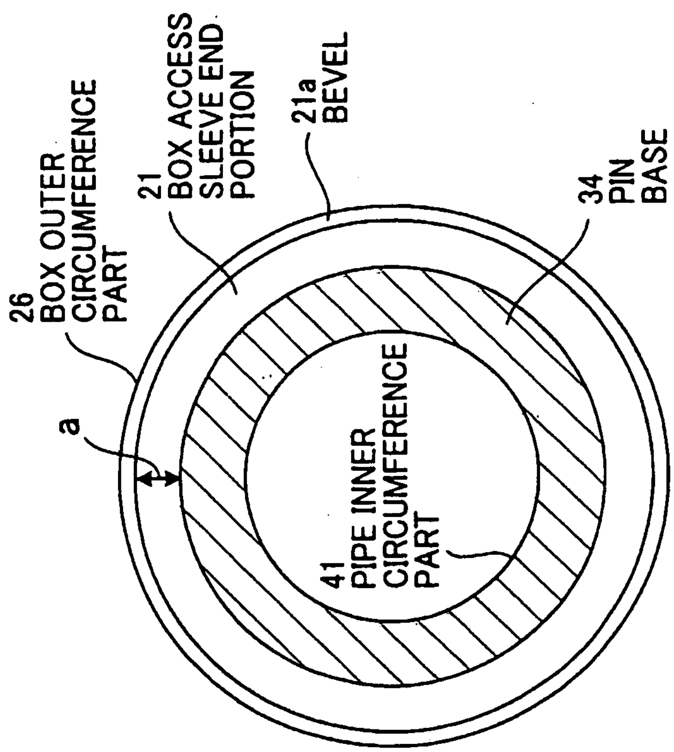

a
26
BOX OUTER
CIRCUMFERENCE
PART
21
BOX ACCESS
SLEEVE END
PORTION
21a
BEVEL
34
PIN
BASE
41
PIPE INNER
CIRCUMFERENCE
PART

FIG. 7A

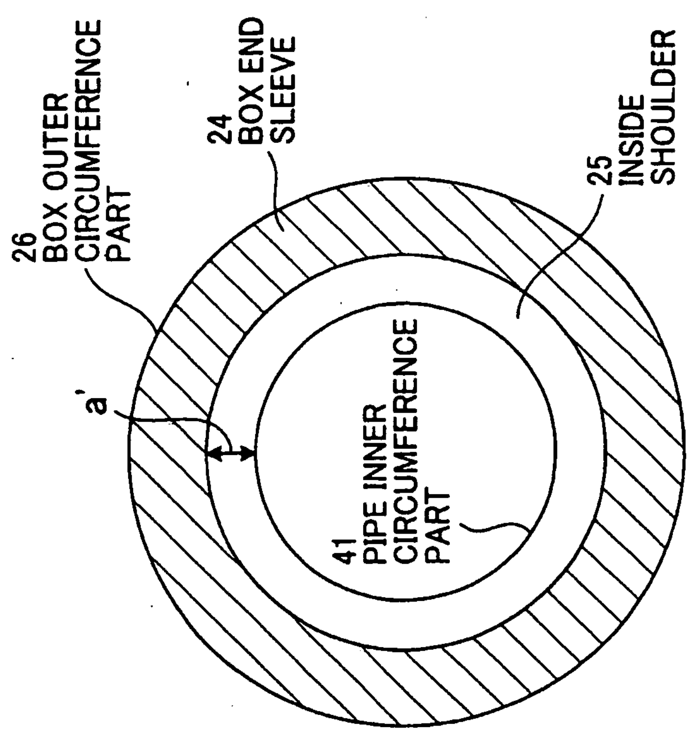

a'
26
BOX OUTER
CIRCUMFERENCE
PART
24
BOX END
SLEEVE
25
INSIDE
SHOULDER
41
PIPE INNER
CIRCUMFERENCE
PART

FIG. 7B

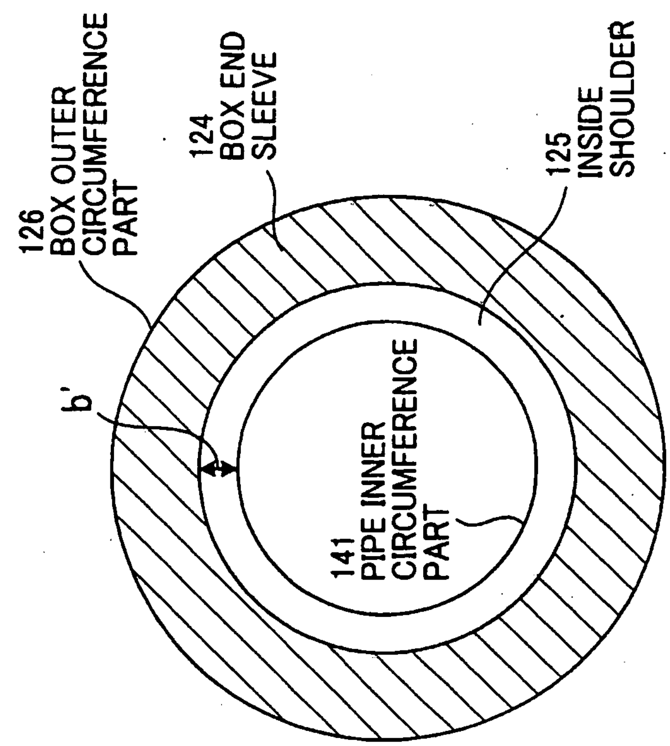
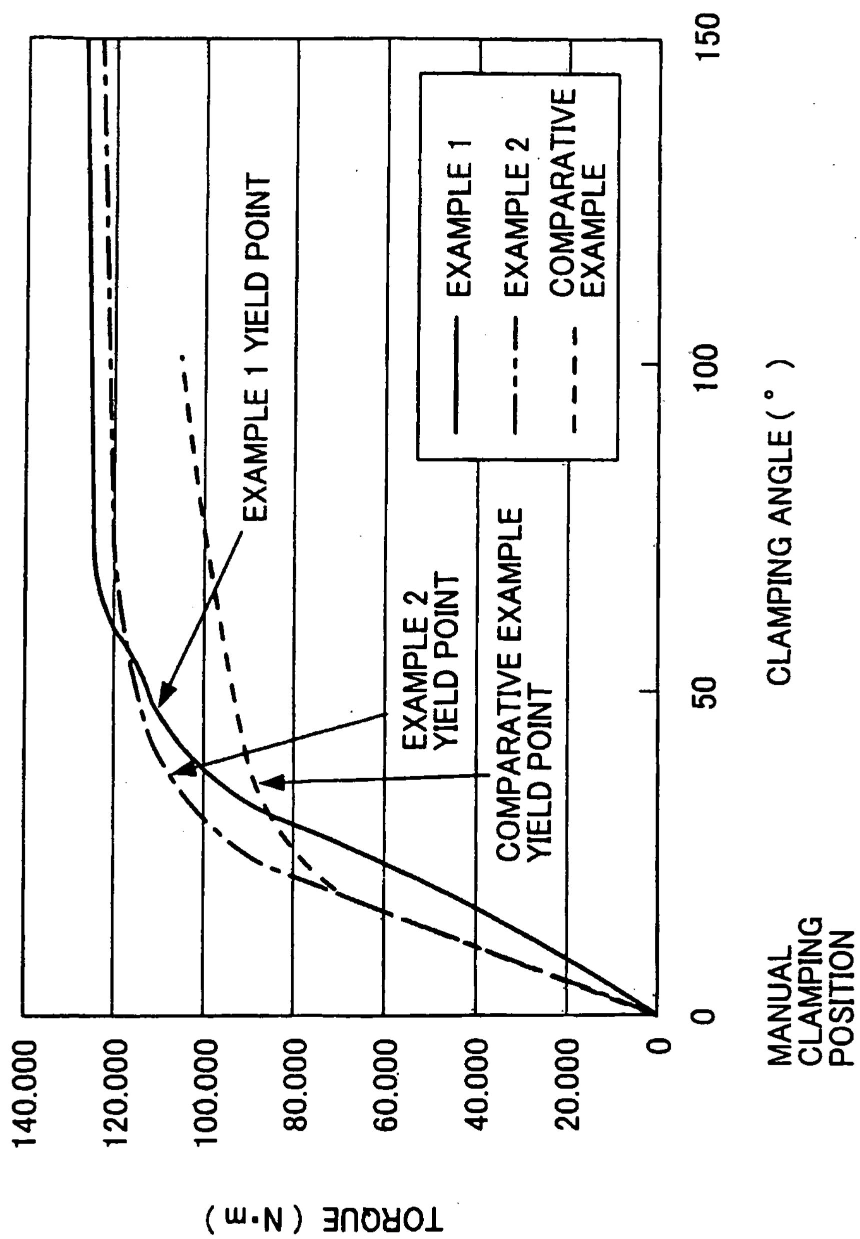

b'
126
BOX OUTER
CIRCUMFERENCE
PART
124
BOX END
SLEEVE
125
INSIDE
SHOULDER
141
PIPE INNER
CIRCUMFERENCE
PART

FIG. 8


TORQUE (N·m)
140.000
120.000
100.000
80.000
60.000
40.000
20.000
0
0
50
100
150
MANUAL CLAMPING POSITION
CLAMPING ANGLE (°)
EXAMPLE 1 YIELD POINT
EXAMPLE 2 YIELD POINT
COMPARATIVE EXAMPLE YIELD POINT
EXAMPLE 1
EXAMPLE 2
COMPARATIVE EXAMPLE

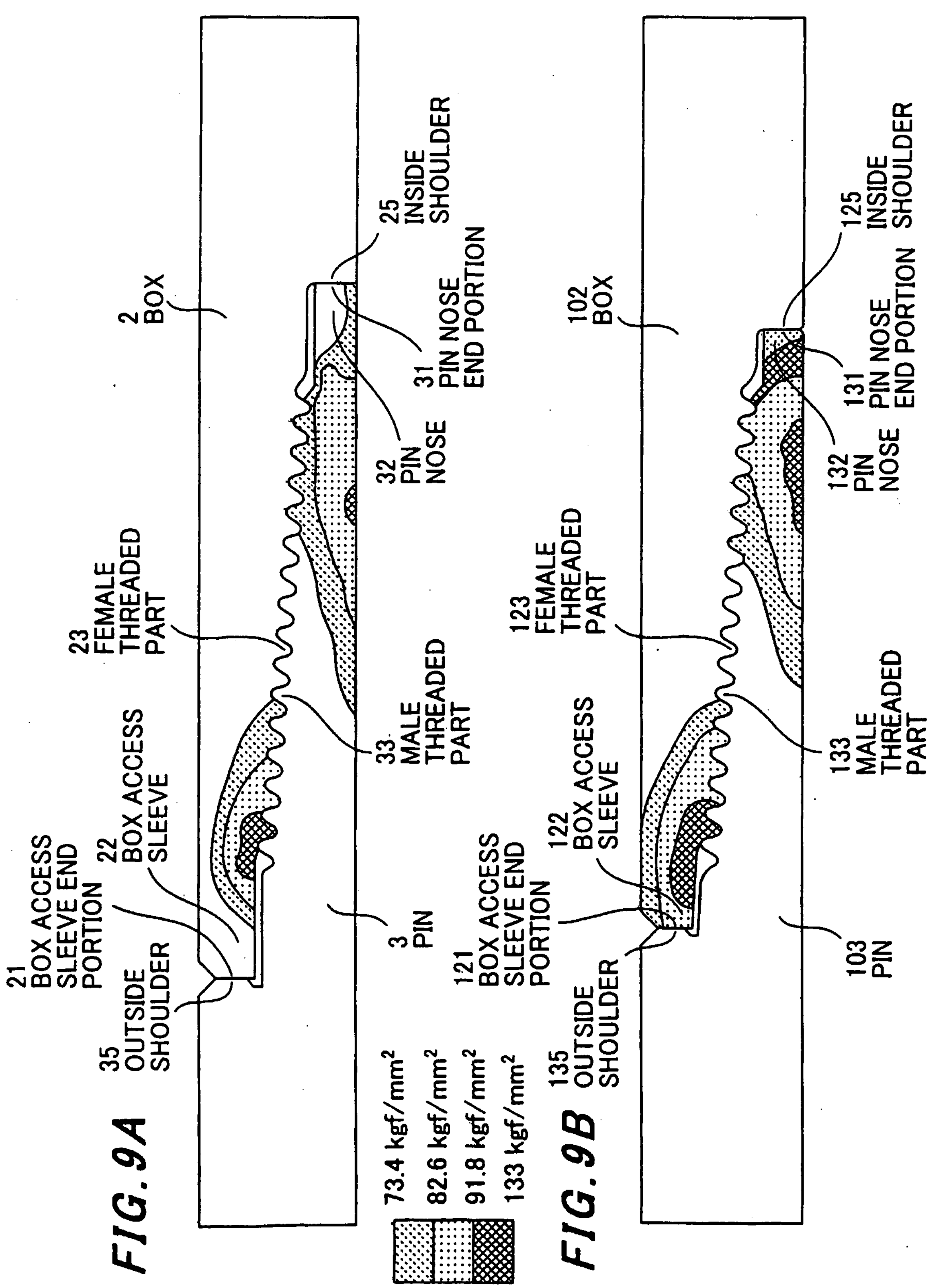

2 BOX
25 INSIDE SHOULDER
31 PIN NOSE END PORTION
32 PIN NOSE
23 FEMALE THREADED PART
33 MALE THREADED PART
22 BOX ACCESS SLEEVE
21 BOX ACCESS SLEEVE END PORTION
3 PIN
35 OUTSIDE SHOULDER
73.4 kgf/mm²
82.6 kgf/mm²
91.8 kgf/mm²
133 kgf/mm²
102 BOX
125 INSIDE SHOULDER
131 PIN NOSE END PORTION
132 PIN NOSE
123 FEMALE THREADED PART
133 MALE THREADED PART
122 BOX ACCESS SLEEVE
121 BOX ACCESS SLEEVE END PORTION
103 PIN
135 OUTSIDE SHOULDER

FIG. 9A

FIG. 9B